

# PLANETARY SPACE WEATHER SERVICE

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# H2020 - A very favorable context

- Before 2016      Smart 1, Rosetta, MEX, MAVEN, VEX, HST, MSL, Dawn
- 2016-2020      Exomars, Juno, HST/JWST, Solar Orbiter
- After 2020      BepiColombo, JUICE, ...

A variety of tools (in the form of web applications, standalone software or numeric models in various degrees of implementation) is available for tracing propagation of Solar events through the solar system and modelling the response of planetary/cometary/asteroid environment to those events. As these tools were usually not designed for planetary space weather applications, additional research and tailoring is required to apply them for this purpose and enable their predictions to be used for virtual solar wind monitors.

N.B.: Solar Orbiter results and new datasets will come right in the middle of H2020

# Summary: JRA activities

- The overall objectives of the JRA will therefore be to review, test, improve and adapt methods and tools available within the partner institutes in order to **make prototype planetary event and space weather services operational** in Europe at the end of the programme

# Objectives JRA4

- **JRA4-PSWS will set up the infrastructure necessary to transition to a full planetary space weather service within the lifetime of the project.**
- To define a service for planetary event and planetary space weather predictions;
- To develop new methods, interfaces, functionalities and/or plug-ins dedicated to planetary space weather from the tools and models already available within the partner institutes;
- To define planetary proxies and reliability factors for planetary space weather applications;
- To validate, compare and enhance the capability of the existing models and tools in order to predict the impact of solar events in the vicinity of Solar System objects; this will in turn lead to a strengthening of our capabilities for robust prediction in the terrestrial environment.
- To identify user requirements, develop a methodology for issuing event alerts, and link those to the planetary event and space weather predictions;
- To facilitate discovery or prediction announcements within the PSWS user community in order to watch or warn against specific events;
- To set up dedicated professional and/or amateur observation campaigns, disseminate contextual information for science data analysis, and enable safety operations for planet-orbiting spacecraft against the risks of impacts from solar wind disturbances and meteors.

# Summary: VA activities

EPN2020-RI will also develop an entirely new Virtual Access service, VA1 “Planetary Space Weather Services” (PSWS). VA1 will make five entirely new ‘toolkits’ accessible to the research community and to industrial partners planning for space missions: a general planetary space weather toolkit, as well as three toolkits dedicated to the following key planetary environments: Mars (in support of ESA’s ExoMars missions), comets (building on the expected success of the ESA Rosetta mission), and outer planets (in preparation for the ESA JUICE mission to be launched in 2022). This will give the European planetary science community new methods, interfaces, functionalities and/or plug-ins dedicated to planetary space weather in the tools and models available within the partner institutes. It will also create a novel event-diary toolkit aimed at predicting and detecting planetary events like meteor showers and impacts. This new facility is expected to have an impact beyond the planetary research community, being strongly linked to the wider space community and industry; it will also be relevant to such diverse enterprises as energy and power supply and telecommunications whose commercial activities depend on space weather. VA1 and its associated JRA4 not only have an impact on planetary space missions, but will allow the “hardness” of spacecraft and their components to be evaluated under a variety of known conditions, particularly radiation conditions, extending their known flight-worthiness for terrestrial applications.

## Our users:

The scientific community, amateur astronomers, industrial partners, space agencies

## Key targets:

support for Exomars, Rosetta, JUICE, BepiColombo missions

## **Objectives VA1**

VA1-PSWS will make five entirely new ‘toolkits’ accessible to the research community and to industrial partners planning for space missions:

1. General planetary space weather toolkit, as well as three toolkits dedicated to the following key planetary environments:
2. Mars (in support of the ESA ExoMars missions to be launched in 2016 and 2018),
3. comets (building on the expected success of the ESA Rosetta mission), and
4. outer planets (in preparation for the ESA JUICE mission to be launched in 2022).
5. Novel “event-diary” toolkit aiming at predicting and detecting planetary events like meteor showers and impacts.

# Objectives VA1

To develop the notion of “**planetary space situational awareness**” activities that are ongoing for Earth as an issue and object for research throughout the Solar System. Europlanet will work closely with the winners of the European Commission’s PROTEC-1-2014 “Space Weather” call, which aims to “observe and to predict a range of solar events that may impact the near Earth environment including orbiting satellites and ground based systems”;

To create a step change in “space weather” monitoring and prediction, in particular of disturbances and extreme events, to **include other planets in the Solar System**. This will have the practical impact of being able to predict how space weather events manifest at different planetary environments as the corresponding structures in the plasma outflow from the Sun – the Solar Wind - evolve and propagate outwards through the Solar System;

To extend the prediction and monitoring of meteor showers from encounters with **comet meteoroid streams**, which can also potentially endanger orbiting satellites, throughout the Solar System;

To **test and validate models throughout the Solar System**. By extending of the know-how established at Earth to new environments we will test current understanding in new sets of conditions, and hence strengthen our ability to make such predictions in our own environment. In particular activities and protocols will implement the recommendations of the upcoming COSPAR roadmap on Space Weather;

To lay the basis for allowing **Solar System space missions**, whether they are on a planetary surface, orbiting or travelling, to be protected in the same way that Earth-orbiting and ground-based facilities will be protected by current “space situational awareness” initiatives;

To make demonstrators of prototyped and consolidated services publicly available within the PSWS to **professional planetary scientists, industry, the space agencies and amateur astronomers**;

To make five entirely new ‘toolkits’ accessible

Mars (in support of the **ESA ExoMars** missions to be launched in 2016 and 2018),

comets (building on the expected success of the ESA Rosetta mission), and

outer planets (in preparation for the **ESA JUICE (JUperiter ICy moons Explorer)** mission to be launched in 2022, and as a potential support service for the **JUNO** mission due to arrive at and start orbiting Jupiter in 2016);

it will also inform planning for the **BepiColombo mission due to launch to Mercury in 2017**



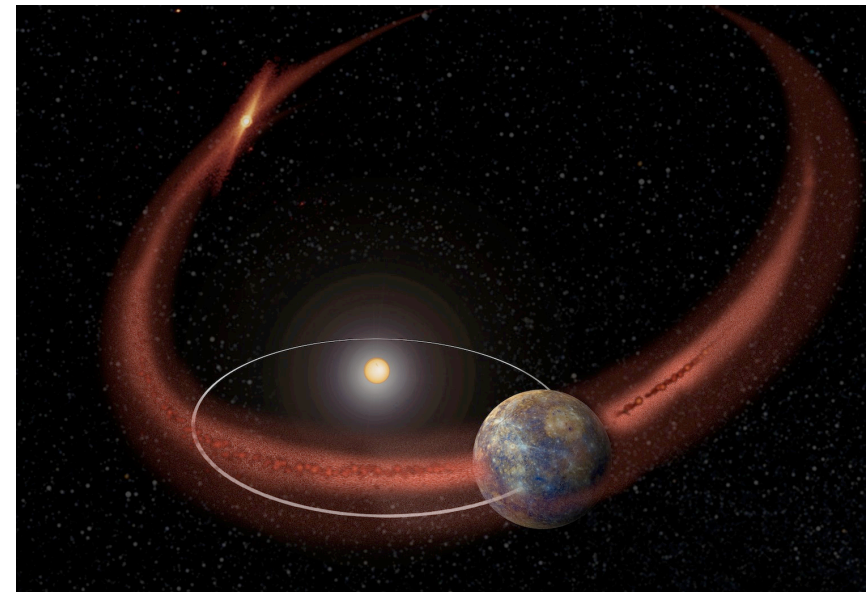
# New services well-received, high potential for public outreach



Siding spring comet at Mars  
MAVEN, MEX, MSL observations

N.B.: Instruments turned-off for  
Safety reasons

Comet Encke causes seasonal  
showers of meteor at at Mercury  
MESSENGER observations



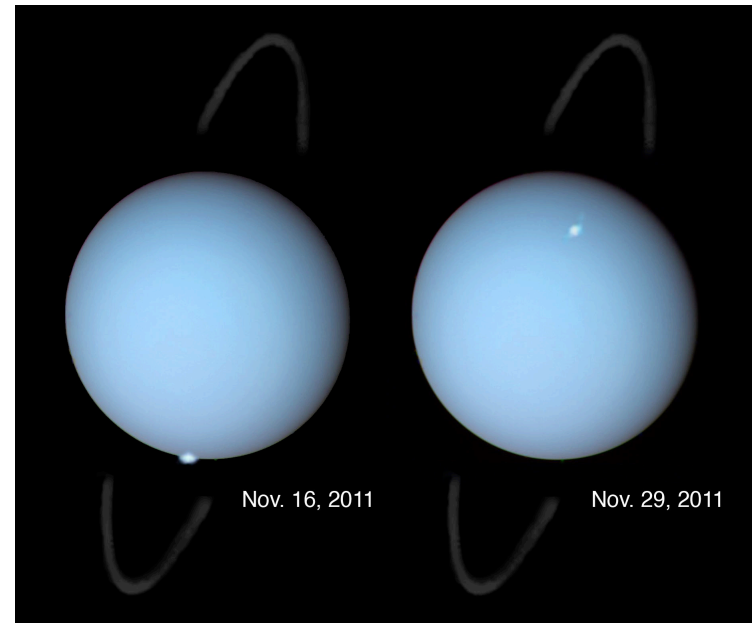


# High potential for scientific return and careful planning of new observations



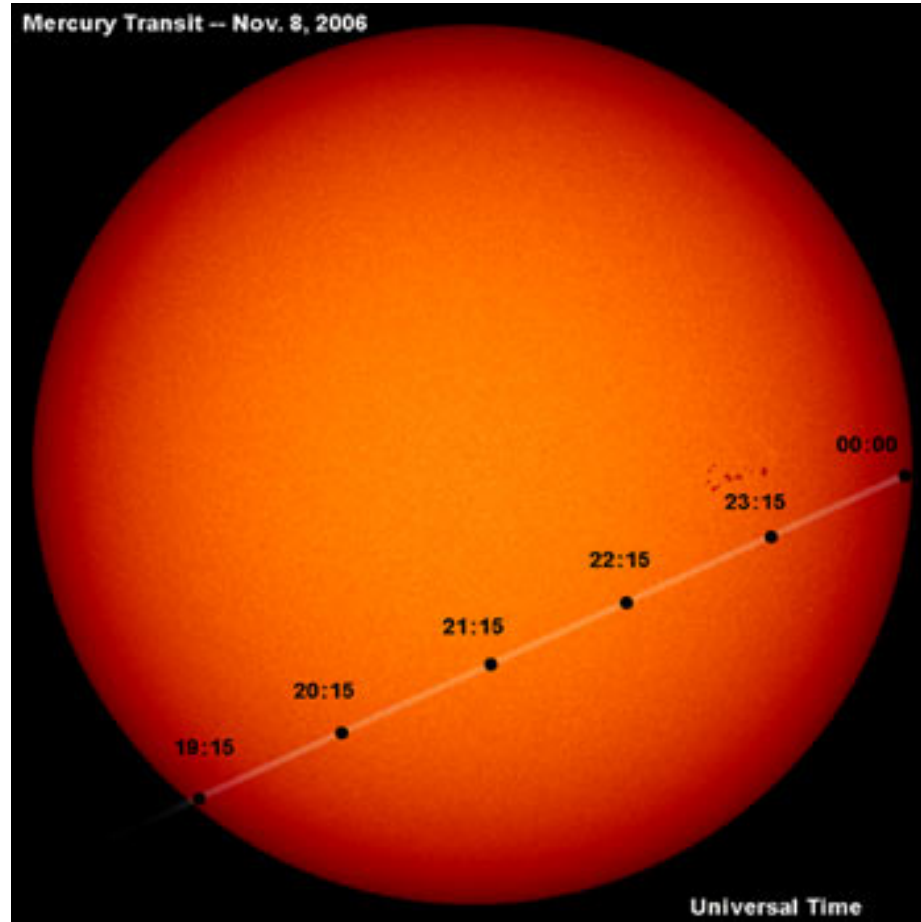
Shoemaker-Levy at Jupiter

Giant planet fireballs at Saturn:  
detection and report at EPSC 2012  
by amateur astronomer A. Wesley



HST observation of **shock-driven**  
auroral emissions at Uranus, by  
Lamy et al. (2012)

# New Opportunities

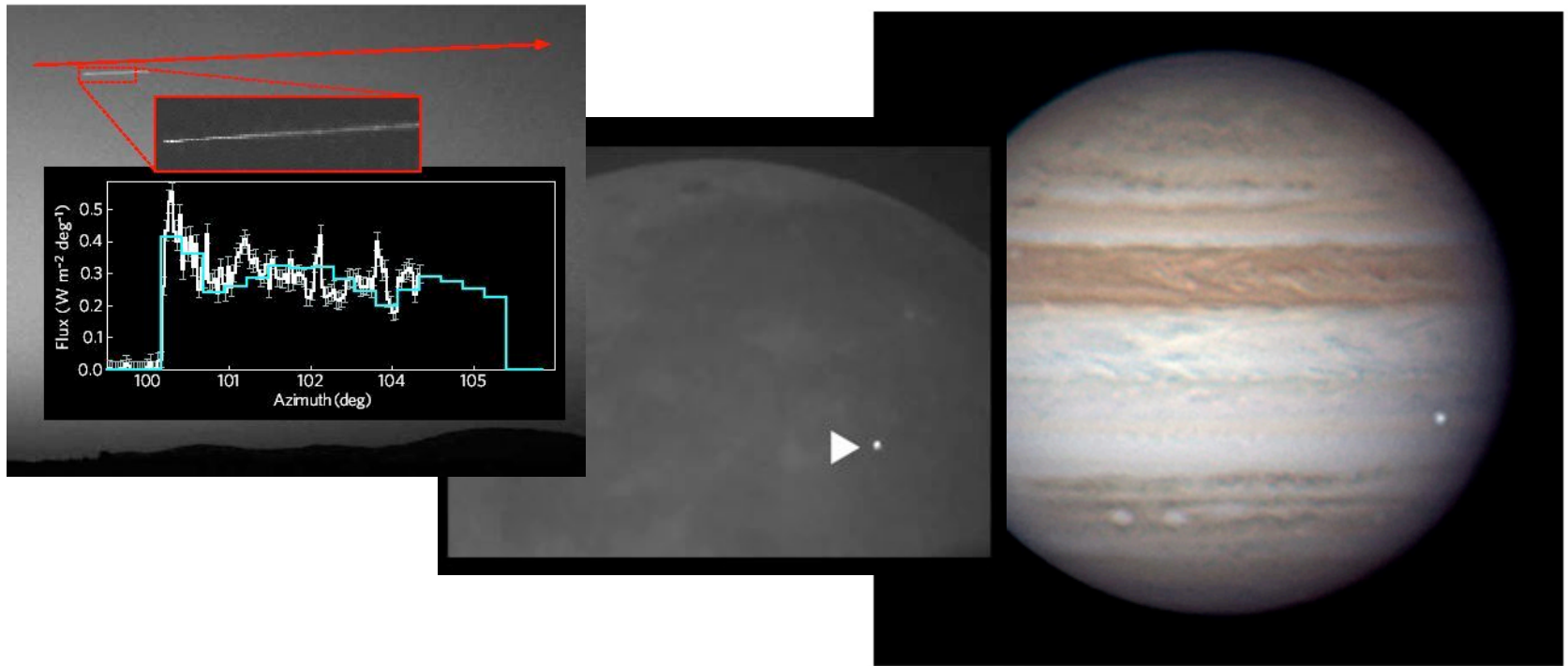


Transit of Mercury 2016

Note also need to communicate PSWS products

# Remarkable events in the Solar System and the role of amateur astronomers

- First shooting star seen from Mars (F. Selsis et al., Nature, 2005)



- Amateur astronomers see perseid hits on the Moon
- Fiercest meteor shower on record to hit Mars via comet
- Explosion on Jupiter spotted by amateur astronomers (A. Wesley)

# New services well reviewed

- **Referee report:**

‘Another important action is the creation of a planetary space weather service that will be important to spacecraft enroute or operating near or on the surfaces of these bodies’

- **Completely new activity:**

Risk mitigation thanks to other Europlanet activities (outreach, networking, workshops, etc)

-> need to interact strongly with them right at the beginning We need a kick-off meeting

Beneficiary	Task	Funding (k€)	Overheads (%)	Total (k€)
<b>CNRS-IRAP</b>	JRA4 Task 2 Tools/Methods	36	25	45
	JRA4 Task 5 Alerts	4	25	5
	VA1 Task 1 Coordination	10	25	12.5
	VA1 Task 2 Implementation	30	25	37.5
	VA1 Task 3 Detection	10	25	12.5
	VA1/JRA4 Meetings	25	25	31.25
		<b>115</b>	<b>25</b>	<b>143.75</b>
<b>GFI</b>	VA1 Task 2 Implementation	46	25	57.5
		<b>46</b>	<b>25</b>	<b>57.5</b>
<b>AU-IMPACS</b>	JRA4 Task 3 Tests	10	25	12.5
	JRA4 Task 4 Prediction	25	25	31.25
	VA1 Task 1 Coordination	10	25	12.5
	VA1 Task 2 Implementation	30	25	37.5
	VA1 Task 3 Detection	35	25	43.75
		<b>110</b>	<b>25</b>	<b>137.5</b>
<b>UCL</b>	JRA4 Task 2 Tools/Methods	30	25	37.5
	JRA4 Task 5 Alerts	5	25	6.25
	VA1 Task 3 Detection	35	25	43.75
		<b>70</b>	<b>25</b>	<b>87.5</b>
<b>OBSPARIS</b>	JRA4 Task 4 Prediction	25	25	31.25
	JRA4 Task 5 Alerts	10	25	12.5
		<b>30</b>	<b>25</b>	<b>43.8</b>
<b>ETSI</b>	VA1 Task 3 Detection	15	25	18.75
		<b>15</b>	<b>25</b>	<b>18.75</b>
<b>IAP</b>	JRA4 Task 3 Tests	50	25	62.5
		<b>50</b>	<b>25</b>	<b>62.5</b>
<b>DLR</b>	JRA4 Task 3 Tests	20	25	25
		<b>20</b>	<b>25</b>	<b>25</b>
<b>CNRS-IPAG</b>	VA1 Task 4 Liaisons	20	25	25
		<b>20</b>	<b>25</b>	<b>25</b>
<b>Wigner</b>	JRA4 Task 3 Tests	20	25	25
	JRA4 Task 4 Reliability	20	25	25
		<b>40</b>	<b>25</b>	<b>50</b>
<b>SRC</b>	JRA4 Task 5 Alerts	4	25	5
	VA1 Task 2 Implementation	16	25	20
	VA1 Task 4 Liaisons	20	25	25
		<b>40</b>	<b>25</b>	<b>50</b>

# Our Team

Some partners have been proposed and included in the last weeks of the proposal phase, following suggestions from management

-> need to learn how to work together

-> limited funding for meetings

Suggestion: take advantage of NA1 and NA2 workshops

# Milestones (internal to PSWS)

Milestone number	Milestone name	Estimated date	Means of verification
M7.1/ M12.1	Kick-Off Meeting	PM 3	Minutes
M7.2	External Review Board	PM 6	Minutes
M7.3/ M12.2	PSWD website	PM 6	D12.1
M7.4	Public release of prototyped Planetary Space Weather services	PM 18	D12.2
M7.5	Public release of prototyped Planetary Diary services	PM 24	D12.4
M12.3	Prototyped Alert services	PM 24	D12.2
M7.6/ M12.4	Coordination Meeting	PM 27	Minutes
M7.7	Review Meeting	PM 30	D12.3
M7.8	Public release of consolidated Planetary Space Weather services with integrated Alert services	PM 36	D12.4
M7.9	Public release of Planetary Diary consolidated services with integrated Alert services	PM 36	D12.4
M7.10/ M12.5	Coordination Meeting	PM 42	Minutes
M7.11	Review Meeting	PM 45	D12.5
M7.12/ M12.6	Final Meeting	PM 48	D12.6

# Our deliverables (official)

- Reviews by VA board of PAB
  - **Suggestion for external reviewers:**
    - O. Witasse (ESA), JUICE project scientist
    - R. Harrison (RAL), HELCATS FP7 project
    - Kirstie Kauristi (FMI), COSPAR Space Weather roadmap
    - Alexei Glover (ESA) SSA project
- Annual report
- Validation report



# Our toolkits

- General space weather toolkit
  - User-friendly versatile MHD propagation code
  - Extension of propagation and space weather tools from CDPP
- Mars toolkit
  - Radiation environment, from extended atmosphere down to surface
- Comet toolkit
  - Solar Wind-Cometary tail interactions
- Outer planets toolkit
  - Solar Wind/Magnetosphere/Ionosphere/thermosphere connections
  - Meteor showers at planets
- Sustainability toolkit
  - Alert system

# A toolkit consists of

- Database
- Software development
- Prototype
- Alerts

# Schedule

- Aims to quickly release first prototypes
  - Comet toolkit (taking advantage of Rosetta)
    - Links with amateur astronomers to be worked on
  - Giant planet toolkit (Juno arriving next year)
    - Propagated solar wind data and auroral campaigns with HST, HISAKI, ground-based observations, etc
  - Mars toolkit (ExoMars 2016)
    - Release of look-up tables for radiation environments (cosmic-rays)

# Websites

please check:

<http://planetaryspaceweather-europlanet.irap.omp.eu/#>

<http://planetaryspaceweather-europlanet.irap.omp.eu/dist/psws.html>

under development



## Planetary Space Weather Services

### Europlanet

Space weather – the monitoring and prediction of disturbances in our near-space environment and how they are controlled by the Sun - is now recognised as an important aspect of understanding our Earth and protecting vital assets such as orbiting satellites and power grids. Europlanet 2020-RI aims to transform the science of space weather, by extending its scope throughout the Solar System. An entirely new Virtual Access Service, "Planetary Space Weather Services" (PSWS), has therefore been included in the project submitted to the INFRAIA-1-2014-2015 call of the EU Framework Programme for Research and Innovation. In order to provide "Phase Zero" space weather related resources during the initial stages of the project, a coordinated selection of models and tools related to planetary and solar environments already available or in development can be accessed [here](#).

#### Service Activities (VA1-PSWS)

VA1-PSWS will make five entirely new 'toolkits' accessible to the research community and to industrial partners planning for space missions: a general planetary space weather toolkit, as well as three toolkits dedicated to the following key planetary environments: Mars (in support of the ESA ExoMars missions to be launched in 2016 and 2018), comets (building on the expected success of the ESA Rosetta mission), and outer planets (in preparation for the ESA JUICE mission to be launched in 2022). This will give the European planetary science community new methods, interfaces, functionalities and/or plug-ins dedicated to planetary space weather in the tools and models available within the partner institutes. It will also create a novel "event-diary" toolkit aiming at predicting and detecting planetary events like meteor showers and impacts.

#### Objectives

VA1-PSWS will give the European planetary scientists for the first time new methods, interfaces, functionalities and/or plug-ins dedicated to planetary space weather and diary in the form of tools and models available within the partner institutes, weather services operational in Europe at the end of the programme.

### Research Activities (JRA4-PSWS)

JRA4-PSWS will set up the infrastructure necessary to transition to a full planetary space weather service within the lifetime of the project. A variety of tools (in the form of web applications, standalone software, or numerical models in various degrees of implementation) are available for tracing, propagation of planetary or solar events through the Solar System and modelling the response of the planetary environment (surfaces, atmospheres, ionospheres, and magnetospheres) to those events. As these tools were usually not originally designed for planetary event prediction or space weather applications, additional development is required for these purposes. The overall objectives of the JRA4-PSWS will be to review, test, improve and adapt methods and tools available within the partner institutes in order to make prototype planetary event/diary and space weather services operational

#### News

- 2015-09-15 : Management meeting at Open University, Milton Keynes, UK
- 2015-09-27 : Kick off meeting in Nantes, France

#### Europlanet tools

#### Tutorials

#### Available on day 1

#### Presentations



# Next steps

- Participant mailing list to be finalized in the coming week
- First meeting by telecon before end of October: review of deliverables and schedule
- Invited poster on PSWS at 12th European Space Weather Week (23-27 Nov. 2015)



# Question

- PSWS will work closely with the winner of the PROTEC-1-2014 Space weather call

Who are they ?

Note that HELCATS has been retrospectively funded

BepiColombo

Transit of Mercury

Need kick off meeting

B